ITEM 686.2888 SOLID STATE MODULAR ZONE MASTER CONTROLLER

DESCRIPTION

The CONTRACTOR shall furnish and install a zone master controller. Controller to be provided shall utilize a micro-processor to implement the control logic with keyboard entry for the timing elements, and can function as a stand alone master, or as a zone master in a traffic control network supervised by a central PC running the appropriate software. The PC software shall be included as a bid item of the zone master controller total bid price.

The zone master controller and software shall be fully compatible with existing County equipment in the field (Econolite ASC8000). No external hardware will be allowed in the "slave" cabinets which the zone master controller is to control. If additional hardware is required, it must be internal to the "slave" controllers (e.g. - a telecommunications board).

The zone master controller shall, as a minimum meet all the requirements of the County of Monroe Special Requirements on Electronic Equipment, NEMA Standard TS1-1983 or latest revision, and the additional requirements specified in the following.

The Contractor shall furnish and install, with the zone master controller, the following:

1. Two complete sets of extender cards to allow the zone master controller unit modules to be operated outside of the controller housing for trouble shooting purposes.

2. One set of non-volatile plug-in memory modules that test the processing unit, the volatile memory and the input and output circuits, and all applicable drawings. A diagnostic Prom shall be delivered as part of the unit if required to "self test" and trouble shoot the unit. If the zone master is self-testing, no modules will be required for this procedure.

3. Manuals, drawings, etc., stated in County of Monroe Equipment Specifications-Electronic Equipment.

4. All wrap around cable & connector assembly to front connections for testing including and "loop back" testing methods.

5. Any other communication jumpers, cables, etc. needed for testing any part of the zone master controller.

6. Memory maps and data specifications for the microprocessor.

7. Zone master software to run under MSDOS 6.0 on an IBM PC (see Special Zone Master Controller Items, "B" and "C").

SPECIAL ZONE MASTER CONTROLLER ITEMS

A. IBM PC with minimum 140MB internal hard drive, one 3 1/2" and one 5 1/4" floppy disk drive, MSDOS 6.0 or later, Microsoft Windows release 3.1 or later and a Microsoft Mouse and pad. The unit shall have a 486 DX processor, 8 MB RAM memory, 33MHz processing speed, internal 8kb cache, and math coprocessor, internal Hayes compatible internal modem, 17" SVGA color monitor on a swivel base, with 1024 X 768, 0.28 mm dot pitch resolution (minimum), and 24 pin dot matrix wide carriage printer capable of printing on wide (378 mm) paper. All manuals and cables are to be included.

B. The Zone Master remote software shall be in a format which can be loaded into and run on the IBM PC describer in B, above. The software shall be operationally verified by the supplier. A user's manual shall be supplied in printed form. A backup software package shall also be supplied on 3.5" or 5.5" diskettes. A menu-driven installation program shall be provided for loading the software. The software shall be configured for a local area network (LAN) such as Novell Network and any hardware needed for the IBM PC.

The supplier of the remote monitor software shall license the County to use the software on the above IBM PC. Any software improvements, enhancements, upgrades or revisions which occur within one year of the contract date shall be furnished to the County at no additional cost.

The remote software shall normally operate in a mode that receives and stores diagnostic events, system management information, program and mode changes, system events, and detector data. When not monitoring information from the Master, the software shall be controlled by the system operator to:

(1) Generate and display, in real time, graphics at the maximum resolution of the monitor.

a. Dynamic zone map display, providing a plan view of up to 24 intersections and 32 system detectors per zone, with text labelling of all major features. Real time components of the display shall include major movement greens and reds for all intersections, and actuation status of all system detectors. Text shall show whether an intersection in on-line, free, has a coordination fault, is in flash or preemption, or has a telemetry failure.

b. Dynamic intersection display, showing the real time operation of a single intersection, including complex multi-legged configurations, and diamonds. the display shall include vehicle and pedestrian signal colors for each active phase, vehicle and pedestrian actuations, and the traffic plan in effect (cycle, offset, split).

c. Dynamic time-space information from up to 8 of the possible 24

intersections per zone, to represent the results of various zone coordination strategies and enable the engineer to fine-tune the system.

d. Utility Programs

Interface between the Zone Master software and the AAP2NEMA conversion program, which in turn converts the output of PASSER-II and TRANSYT-7F into NEMA format.

Conversion program to generate detector log and event log information files in ASCII format suitable for importing into external spreadsheet and data base management programs for further analysis.

Screen capture utility program to produce intersection and zone graphics from external software such as Paintbrush 4+.

(2) Issue manual commands to the Zone Master.

(3) Provide zone master and slave controller data base management as follows:

a) Upload and download data base from controllers

b) Edit data base

c) Print reports

C. Training: Training shall consist of two sessions of 2 days each for a total of 4 days, at the Rochester site. The first session shall be at the time of installation. The second session shall be 4 weeks later.

ZONE MASTER OPERATIONS

FUNCTIONAL REQUIREMENTS

The zone master controller shall control the operation of a traffic system or zone containing up to 24 intersections by specifying the operation of the intersection controllers based on processed detector data, time-of-day/day-of-week/week-of-year scheduling, manual operator selection, or external commands.

The control signals shall consist of traffic plans that specify a coordination program that commands one of six cycle lengths, one of five offsets, one of four splits; system free; or zone plan, and up to four special functions.

The system master shall provide for a communication link to a monitor computer to

upload/download controller data bases, to transfer events and detector data for storage, and to provide data on a one-second basis for real-time displays.

There shall be capability for telemetry interconnect and for a remote or local data terminal.

TELEMETRY

Up to two channels of telemetry utilizing time division multiplex/frequency shift keying (TDM/FSK) techniques shall be provided depending on system requirements.

The modems for each channel shall provide full-duplex communications over four-wire Type 3002 telephone lines between the system master and local controllers.

The transmitter shall be a digital-to-FSK modulator.

A digital HIGH shall result in a frequency to 2200Hz, and a digital LOW shall result in a frequency of 1200 Hz. At the point of frequency shift, the signal shall be phase coherent. The nominal output level shall be 0 dBm into a 600 ohm load.

The receiver shall be an FSK-to-digital demodulator.

A frequency of 2200 Hz shall result in a digital HIGH, and a frequency of 1200 Hz shall result in a digital LOW. The receiver sensitivity shall be set at -34 dBm and shall be adjustable from -40 to +6 dBm.

PROGRAM SELECTION

The default program in effect shall be selected on a priority basis. Priorities shall be as follows:

1) Manual entry from keyboard

2) External command from a master

3) Time-of-day/day-of-week schedule

4) Traffic responsive

Manual entry from the keyboard shall override programs from all other sources. It shall be used as the default when automatic selection fails and time-of-day/day-of-week backup is not enabled.

Provisions shall be made for program commands from an external master. The external command inputs shall be usable for crossing artery synchronization.

TIME-OF-DAY/DAY-OF-WEEK PROGRAMMING

Up to 150 program steps shall be available for time-of-day/day-of-week (TOD) scheduling. Up to 16 TOD programs shall be possible. The TOD programs shall be scheduled on a repeating basis by assignment to the week of year and day-of-week. Special TOD programs shall be assignable by month and day on a one-time or repeating basis for implementing holiday programs or special events.

TOD program selection or special function scheduling shall be enabled separately for override of traffic responsive commands. It shall be possible to enable a traffic responsive default function that allows TOD operation to take effect only if traffic responsive operation fails.

TOD operation shall be controlled by a calendar and clock that compensate automatically for leap year and daylight savings time (if enabled). Each TOD program step shall consist of the following:

1) Program number

2) Begin time (hour and minute)

3) Traffic plan consisting of cycle, offset and split; system free; of zone plan command (see "Default Plan")

4) Enable special functions

5) Enable maintenance call operation

6) Enable traffic responsive operation

7) Auto program override (if cycle length is higher)

8) Command non-interconnected coordination operation

9) Enable crossing artery synchronization

10) Specify sample period for traffic responsive plan

11) System detector log interval

12) Sample period interval

Power OFF for longer than the capability of the power-down timer shall inhibit TOD operation. TOD operation shall be enabled when time is updated.

TRAFFIC RESPONSIVE PROGRAMMING

Traffic plan selection in the traffic responsive mode shall be performed at user specified intervals. The plan selection interval shall be specified in minutes or cycles.

Raw sensor data consisting of volume counts and presence measurement from up to 32 detectors shall be processed into scaled volume and scaled occupancy traffic parameter values for use in traffic responsive plan selection. The volume and occupancy scale factors shall be specified for each detector and also for the system. If individual values are not specified, the system value shall be used.

The sensors shall be assignable to eight detector groups, each of which shall contain up to four detectors. A minimum number of operable detectors required for valid operation shall be user specified. Each group of detectors shall be assignable to any combination of the following functions:

1) Level selection

2) Direction 1 traffic

3) Direction 2 traffic

4) Split demand A

5) Split demand B

6) Arterial demand

7) Non-arterial demand

For each detector group assignment, the user shall be able to specify that the highest, second highest or average of all scaled sensor data be used as the detector group output. The output parameter of each detector group shall be volume, occupancy, or concentration (which is the highest of volume or occupancy).

The data processing of the detector group outputs assigned to each function shall be specified as follows:

1) Parameter (volume, occupancy, or concentration)

2) Highest, second highest, or average output of the detector groups assigned to the function.

3) Factor used in a first-order smoothing algorithm.

4) Update predictor value that will bypass data smoothing for a predetermined

increase. Computed level shall be determined by comparing the processed level selection detector group outputs to user specified threshold values. Provision shall be made for determining up to five computed levels. The threshold values between adjacent levels shall overlap to provide a hysteresis effect to minimize oscillation. It shall be possible to inhibit access to higher levels by entering on out-of-range threshold value.

Arterial directional preference shall be determined by computing the difference between the processed direction 1 data and direction 2 data. Computed offset shall be determined by comparing the arterial directional values to user specified threshold values. The computed offset shall be either the direction 1 preference, direction 2 preference, or average. The threshold values between adjacent computed offsets shall overlap to provide a hysteresis effect to minimize oscillation.

Based on computer level and computed offset, one of fifteen traffic plans shall be selected. Traffic plans shall provide for one of the following:

1) A coordination plan consisting of:
   One of six cycle lengths
   One of five offsets
   One of four splits or four computed split/special function programs.

2) System free

3) Zone plan command:
   Up to four special functions shall be available for each traffic plan.

Zone plan commands 1 through 32 from the master shall select command programs 1 through 32 at each intersection controller. It shall be possible to group intersections as necessary for traffic patterns providing multiple sub-zone coordination or independent operation within a zone. As an example, zone plan command 1 shall be able to specify the following zone operation:

1) Intersection 1 through 8, command program 1 calling for cycle 2, offset 3, and split 1.
2) Intersection 9 through 16, command program 1 calling for cycle 3, offset 2, and offset 2.
3) Intersection 17 through 20, command program 1 calling for free mode.

If due to failed detectors or improper data entries, the computed level or computed offset cannot be determined, the previously selected traffic responsive plan shall be retained for a period specified by the operator. A default traffic plan shall be used if valid computer level and offset have not been determined before the expiration of the retention period.

DEFAULT PLAN

The default plan shall be selected form one of three sources as determined by operator entries.

1) TOD scheduling shall be used if traffic responsive backup is enabled.
2) Manual plan
3) System free

Computed split/special function program shall be determined by computing the difference between the processed split demand B data and split demand A data. One of four programs consisting of one of four splits and any special function shall be selected by comparing the difference to user specified values. The threshold values between adjacent splits shall overlap to provide a hysteresis effect.

Five additional traffic plans shall be selectable based on computed level and non-arterial preference. A non-arterial preference ratio shall be determined by computing the difference between the processed non-arterial demand data and arterial demand data. Either arterial or non-arterial preference shall be selected by comparing the difference to user specified threshold values. The threshold values shall overlap to provide a hysteresis effect. It shall be possible to specify that any of the non-arterial traffic plans shall defer to the arterial plans at the same computed level.

CROSSING ARTERIAL SYNCHRONIZATION

Provision shall be made for crossing arterial synchronization in two independent system masters. Synchronization shall be established through the common intersection of both systems in order to maintain simultaneous, coordinated traffic flow along each of the arterials.

Crossing arterial synchronization shall be enabled by the time-of-day scheduler and shall occur when the traffic pattern commanded by each of the system master has the same cycle information.

Crossing arterial synchronization shall be enable as long as both system master cycle commands are the same and shall remain in effect for as long as traffic demand warrants this mode. To prevent oscillation, it shall be possible to "lock in" this mode for a user-programmable period from 0-30 cycles.

CLOCK/CALENDAR

The zone master controller shall provide a time-of-day (TOD) clock. The only required clock settings shall be the current time (hour, minute, and second) and date (month, day and year). Day of week and week of year shall be automatically computed from the date setting. This clock shall be used for all time based control functions.

Clock Accuracy:

The TOD clock shall use the power line frequency as a time base. When power is removed, the time shall be maintained by a crystal oscillator.

The oscillator shall maintain the time to within ± 0.005%, as compared to the Universal Mean Coordinated Time Standard. This accuracy shall be maintained over the NEMA Standard temperature range regardless of the number or rate of power failures.

The zone master controller shall maintain the TOD clock during power outages of up to 30 days.

Time and Date Entry:

Time and date information shall be entered in the controller unit through the following methods:

1) The controller unit keyboard
2) Transferred from another controller unit or computer
3) Updated via system communications

Leap Year and Daylight Savings Time:

The TOD clock shall automatically compensate for leap year changes. Daylight savings time changes shall be selectable not to occur, or occur automatically as defined by law.

POWER FAIL RESTART

A power down timer shall accumulate the period that power is off for up to 72 hours. Upon restoration of power, the value in the power down timer shall be used to update the clock and calendar. In case power is off longer than 72 hours, the clock and calendar shall not be updated, and a clock error shall be indicated on the status display. Program selection shall not use TOD scheduling until the clock and calendar are manually updated.

At the time power is restored, the traffic responsive program shall be restored to its previous value in case power has been off less than the traffic responsive retention period. If power has been off longer than the retention period the traffic responsive plan shall be set to a default condition.

Changes to the traffic responsive program shall be inhibited for an operator entered number of sample periods or as specified in the backup program to allow computed data to recover. In either case, the traffic plan in effect shall be determined by the highest priority program source for which a plan is specified.

DEVICE DIAGNOSTICS

Diagnostic tests shall automatically be performed on detector data, telemetry

communication, and intersection operation when connected by telemetry. If a diagnostic test determines a fault condition, a fault isolation procedure shall be operator selectable by a keyboard entry that will display the device identification and cause of the diagnostic fault.

An alarm output shall be provided for signaling a diagnostic fault. Provision shall be made for the operator to enable the alarm for each category of diagnostic fault.

DETECTOR DIAGNOSTICS

The system detector raw data shall be tested against user supplied values to determine if the detector is functioning properly.

Four different tests shall be performed. Failure of any test shall cause the detector to be considered as failed and the detector data shall not be used for traffic responsive plan selection.

Provision shall be made for two sets of diagnostic values for no-activity and maximum presence. One set shall be specified on a system basis for all detectors. A second set shall provide for diagnostic values to be specified for each system detector individually. The individual value shall be used if it is longer than the system diagnostic interval. When no individual value is specified for a system detector test, the system diagnostic value shall be used.

The system detector diagnostic tests shall be as follows:

1. **No Activity** - Two intervals from 0 to 255 minutes between vehicle counts shall be settable by time of day for no-activity diagnostics on a system basis. A diagnostic interval shall begin each time a vehicle count occurs. If a vehicle count is not received during the diagnostic interval, the detector shall be failed. No-activity diagnostics shall be inhibited if the volume from a majority of unfailed system detectors is below a system-specified threshold value from 0 to 255 counts per minute.

2. Maximum Presence - An interval from 0 to 30 minutes shall be specified for maximum presence diagnostics. A continuous detector call for the diagnostic interval shall cause the detector to be failed.

3. Minimum Presence - An interval from 0 to 15 minutes and a minimum average presence time from 0 to 30 occupancy counts, where each count is 16 2/3 milliseconds, shall be specified for minimum presence diagnostics. A detector shall be failed if the occupancy per vehicle count averaged over a one minute period is less than the specified average presence time for the diagnostic interval.

4. Excessive Counts - A diagnostic count from 0 to 180 counts per minute and diagnostic interval from 0 to 30 consecutive minutes shall be specified. If the

detector count is equal to or greater than the diagnostic count for the diagnostic interval the detector shall be failed.

Speed trap detector status shall be tested for no-activity. If a speed trap readback does not contain a speed for the current no-activity period, the speed trap shall be failed.

Failed detectors shall be automatically returned to service if no failure condition exists for a 0 to 15 minute detector recovery interval.

A display showing diagnostic status for system detectors shall be provided. The diagnostic status of four system detectors shall be displayed simultaneously. Displayed information for each system detector shall include: enable, telemetry, no activity, max presence, min presence, and excessive counts.

TELEMETRY DIAGNOSTICS

Diagnostics shall be required for telemetry interconnect. The diagnostics shall monitor readbacks for no-response conditions. Channel diagnostics and local telemetry shall be included.

1. Channel - A transceiver failure shall be detected if a telemetry channel is enabled, but no telemetry module is present. A loop failure shall be detected when no readbacks are received on a telemetry channel for 3 seconds. The telemetry channel shall be automatically returned to service and the status of all devices connected to the channel shall be cleared when readbacks are received for 3 consecutive seconds following either failure.

2. Local Telemetry - A local telemetry failure shall be detected when a device has not responded with a valid readback for 5 consecutive seconds. This failure shall be identified with controllers and system detectors only. The device shall be automatically returned to service and the device status cleared when valid readbacks have been received for 5 consecutive seconds following a local telemetry failure.

A diagnostic display showing enable status, loop error and transceiver error for two channels simultaneously shall be provided.

INTERSECTION DIAGNOSTICS

Diagnostics shall be provided for intersections with telemetry interconnect. Intersection status conditions shall be available for diagnostic display and logging.

Controller readbacks shall provide data for determining the following intersection conditions:

1. **Conflict Flash** - A minimum flash interval from 0 to 30 seconds shall be specified. If an intersection readback indicates a CMU flash for a period in excess of the

minimum flash interval, the intersection shall be failed and the intersection status shall indicate a conflict flash condition.

2. **Local Flash** - If an intersection readback indicates flash, CMU flash is OFF, and flash is not commanded from the master, the intersection status shall indicate a local flash condition and the intersection shall be considered off-line.

3. **Commanded Flash** - If an intersection readback indicates flash, CMU flash is OFF, and flash is commanded from the master, the intersection status shall indicate a commanded flash condition and the intersection shall be considered off-line.

4. **Maintenance Required** - If an intersection readback indicates a maintenance required condition, the intersection shall be failed and the intersections status shall indicate a maintenance required condition.

5. **Cycle Fail** - If the readback from a coordinated intersection indicates that a sum check is present and there has not been a phase change for two cycles if coordinated or three minutes if non-coordinated the intersection shall be failed and the intersection status shall indicate a cycle fail condition.

6. **Coordination Alarm** - If an intersection readback indicates a coordination alarm, the intersection shall be failed and the intersection status shall indicate a coordination alarm condition.

7. **Local Free, Commanded Free, Coordination Error, or Preempt** - If an intersection readback indicates any of these conditions, the intersection status shall indicate the condition and the intersection shall be considered off-line.

8. On-line - When a failure of off-line condition is removed, the indication shall be removed from the intersection status, and the intersection shall be recorded on-line if no other failure or off-line condition is present.

Supplemental status readback shall provide data for determining the following local vehicle detector conditions:

1. **No Activity** - Same as for the system detector, except that no individual detector value is specified.

2. **Max Presence** - Same as for the system detector.

Supplemental status readback shall indicate when a minimum of two user defined alarms go ON or OFF. The alarm condition shall be indicated in the intersection status.

A display showing diagnostic status for intersections shall be provided. The diagnostic status for a minimum of four intersections shall be displayed simultaneously. Display

information for each intersection shall include: enable, telemetry, cycle fail, CMU flash, maintenance required, coordination alarm, alarm 1, and alarm 2.

SYSTEM MANAGEMENT

Provision shall be made for keyboard control of the following system management functions, which deal with system configuration, operational status, and status monitoring.

1) Add/delete telemetry connected controllers

2) Add/delete telemetry connected system detectors

3) Alter telemetry channel command sequence

4) Enable/disable telemetry channel

5) Enable/disable controller

6) Enable/disable system detector

Provisions shall be made for status displays of the following categories:

1. **General Status** - Shall display master number, time-of-day, date, day-of-week, program in effect, cycle countdown, special function, time-of-day interval and plan, and overall diagnostic status. In addition, plan and selected cycle length of manual, external, time-of-day, and traffic-responsive plans shall be displayed.

2. **System Detector Current Sample** - Shall display actual and scaled volume and occupancy for all system detectors in groups of eight.

3. **Sample Period Results** - Shall display current plan selected by traffic responsive calculations. Intermediate results shall also be displayed including all eight detector group computed values.

4. **Controller Status** - Shall display information retrieved from intersection controllers through telemetry channels. Current phase 1 - 8 green, vehicle detector 1 - 8 status, overlap A-D green, and alarm status shall be displayed on one screen.

5. **Detector Presence and Speed Traps** - Shall display system detectors 1 - 32 actuation status and speed traps 1 - 8 speed on one screen.

EVENT RECORDING

An event recording function shall be provided for the occurrence of events relating to system operation. Events shall include the following:

1) Program and mode changes
2) Device diagnostics
3) System events

Events shall be recorded as they occur. It shall be possible to enable/disable any event and to assign event priorities to control automatic reporting to a monitor computer on the following basis:

Priority 1 - reports immediately

Priority 2 - reports after 0 - 255 minute delay

Priority 3 - reports with higher priority reports

An event buffer shall be provided for 250 events. Provision shall be made for the event buffer to be printed out on command and for the event buffer to be cleared.

Event messages shall include the master number, event priority, date and time, a brief description of the event, and identification of the system device if applicable.

Information shall be recorded as follows for program or made change events, which may occur automatically as a result of traffic computations, on a TOD scheduled basis, or due to a manual or extended command:

1) In-effect program change
   Program source
   Program cycle, offset, split and cycle length

2) Traffic responsive program change
   Computed selection parameters level, offset, split
   Non-arterial preference
   Program cycle, offset, and split

3) Special function change
   Change source
   Special function number with ON/OFF status

4) Time-of-day program step change
   TOD program step number

5) Intersection mode change
   Intersection number
   Change source
   Intersection mode number with ON/OFF status

Device diagnostics previously defined shall be continuously executed and be recorded as events occur.

System events shall include the following:

1. **Power Off** - A power OFF event shall be recorded when power is removed. The event message shall be printed out when power is restored. Date, time and traffic responsive program shall be preserved in memory for a minimum of 30 days during power OFF. A 72 hour power down timer shall be enabled when loss of power is detected so that the day and time may be corrected when power is restored.

2. **Power On** - A power ON message shall indicate the time power was restored. The date and time shall be corrected if power has been off less than 72 hours.

3. **Power Interrupt** - A power interrupt event shall indicate that power was off for less than 0.75 seconds.

4. **Clock error** - A clock error message shall indicate the date and time is incorrect. This event occurs at initial power ON prior to the date and time being set and if power has been OFF in excess of 72 hours. A clock error shall inhibit TOD operation.

A telephone number entry shall be programmable to allow event reporting to a monitor computer. Another telephone number shall be programmable to report device failures or optionally all priority 1 events to a separate maintenance computer or to a terminal. Event reports to a maintenance computer or terminal shall be done only when scheduled by a TOD entry. If the monitor computer, maintenance computer or terminal is busy or off-line, a reporting system master shall repeatedly attempt to call at a user-programmable retry interval.

LOGS AND REPORTS

Logs and reports shall be generated in response to operator requests. The reports shall consist of the following:

1) Current status
2) System detector log
3) Speed log
4) Detector buffer data

Current status reports shall be available for request by the operator on a one-time basis. The following status reports shall be provided:

1) Zone status consisting of:
Program-in-effect and source

Auto program (if not program-in-effect)
Special function status
Intersection mode
Telemetry channel status:
On-line
Off-line
Failed
Controller status:
On-line
Off-line
Failed
System detector status:
On-line
Off-line
Failed
Local detector status:
Failed

2) Summary of currently failed controllers and failure cause.

3) Summary of currently failed system detectors and failure cause.

4) Current 15 minute system detector log.

5) Contents of event buffer.

System detector logs shall be available for all system detectors. The logs shall present actual volume, actual occupancy and computed speed. The logging interval shall be selectable as 15, 30, or 60 minutes as scheduled by TOD entries. The operator shall be able to enable or disable the log without affecting the previous selections. It shall be possible to specify that speed be computed in miles per hour or kilometers per hour. The log shall be reported to the monitor computer on a real-time basis.

A speed log shall tabulate in three speed bands the number of vehicles detected by each speed trap assigned to log. Up to 8 speed traps shall be independently specified as a measure of effectiveness (using nominal progression speed for each active cycle and offset program as a reference) or as a programmable speed band. The measure of effectiveness method shall provide a speed offset below and a speed offset above the nominal speed for establishing speed bands, whereas the programmable speed band method shall provide two independent speeds to define three speed bands. The logging interval shall be the same as for system detector logs and shall report to the monitor computer on a real-time basis.

A sample period log shall be available to allow the user to evaluate traffic responsive system control. It shall be possible for the operator to adjust detector scale factors, computational parameters, smoothing factors and thresholds, and to monitor the resultant

effect on program selection. It shall be possible for the operator to specify the log printout on a multiple of sample periods from 1 to 15 as scheduled by TOD entries; or, alternatively to print out the sample period log when a change occurs to computed level, offset, split or non-arterial preference. The operator shall be able to enable or disable the log without affecting previous selections. The sample period log shall consist of the following parameters:

1) Scaled volume and occupancy from enable system detectors
2) Volume for each detector group
3) Occupancy for each detector group
4) Concentration for each detector group
5) Current value of each program selection function
6) Smoothed value of each program selection function
7) Computed program selection parameters
8) Selected auto program
9) In-effect program and cycle length

The sample period log shall be reported to the monitor computer on a real-time basis.

A user-enabled log buffer shall accumulate data from enabled system detectors and speed traps for each logging interval. Contents of the log buffer shall be transferred at 6, 12 or 24 hour intervals to the monitor computer for storage. A separate telephone number shall be provided for calling the monitor computer via an external modem using the dial-up telephone network. This telephone number shall also be used for real-time logs.

CONSTRUCTION DETAILS

The controller unit shall consist of a main frame, suitable for shelf mounting, with printed circuit card cage and backplane to house and interconnect all operating modules.

Programming the controller shall be accomplished by establishing all timing intervals and selecting all modes of operation by means of adjustments which are directly accessible from the front of the controller. This would exclude portable type programmer/ display units. All programming shall be by means of front panel mounted keyboard. This keyboard shall employ discrete keys which give "tactile feedback" and visual evidence of excursion when exercised. The keys shall be environmentally sealed. The keyboard shall not be an integral part of the controller unit front panel, but shall be removable, in its entirety, from the front panel for service and/or replacement. A debounce circuit shall be provided for the keyboard.

Indicators shall be as specified in NEMA Standard TS1-1983 or latest revision.

DESIGN

The zone master controller shall be modular in design for ease of repair. All boards shall be keyed to prevent improper installation.

The zone master controller shall feature a menu driven format which uses a front panel keyboard with a forty (40) column by sixteen (16) row liquid crystal display as a minimum.

The keyboard shall have tactile feedback so as to insure a positive input. (See "Construction Details")

The main menu shall be in English/Traffic Engineering terminology for the major categories of programming data, where user selects the appropriate category and there is prompted for addition entries.

The LCD display shall have a minimum of four (4) adjustable contrast settings and E-L or LED backlight to provide for easy to read displays under all lighting conditions.

Extensive monitoring capabilities shall be provided by dynamic displays. Over all and specific intersection timing shall be easily viewed by the user. Displays shall include error messages to help with fault isolation.

User programmed settings shall be stored in non-volatile EE PROM. Designs using a battery to maintain user data shall not be acceptable.

To facilitate the transfer of data from one system to another, the EE PROM shall be mounted on an easily removable sub-module, which shall be connected to the processor module via a DIN printed circuit board connector.

A battery back-up shall be provided for critical control "chips" during power failures. The battery shall be a lithium type with a thirty (30) day minimum rating, with a three (3) year life as a minimum. Lead-acid, nickel-cadmium, or alkaline batteries shall not be acceptable.

A modem module or card shall be part of the zone master controller so the unit can be up loaded/down loaded via voice grade telephone lines or interface with a personal computer, or communicate to a printer by a standard RS232 port and format. Program loading shall be accomplished via the front keyboard, down load from another Master, down load from a PC DOS or MS DOS compatible computer, or the data module transfer from one zone master controller to another unit.

SPECIAL REQUIREMENTS

The Zone Master shall be "address" addressable so that each Zone Master shall have a distinct I.D. The Zone Master must also be able to communicate with a 900MHZ point to multi-point radio system, such as a Microwave Data System, using a MDS2130 HSu "Smart Master Station" and DMS2350 remote telemetry units.

AUTOMATIC DIAGNOSTIC DURING NORMAL OPERATION

The following items will be checked automatically while the unit is running.

1. Prom test
2. Ram test
3. CPU test
4. EE Prom test

MECHANICAL REQUIREMENTS

MAIN FRAME

The main frame shall provide housing, mounting, and all necessary internal interconnection. The main frame shall be equipped and wired with a card cage and a backpanel with appropriate connectors to receive a full complement of plug-in modules. All plug-in modules shall be easily removable from the card cage without the use of special tools, or controller disassembly.

SIZE

Maximum dimensions of the main frame shall be:
Height 254mm
Depth 330mm (including connector protrusion)
Width 406mm

FINISH

All exterior surfaces to the main frame shall be etched and painted if aluminum or primed with a zinc chromate printer and painted if a ferrous metal. Anodized surfaces shall be permitted.

MODULARITY

The electronics shall be modular and shall consist of vertical circuit boards. Horizontal circuit cards shall not be acceptable.

ELECTRICAL REQUIREMENTS

POWER

The unit shall be designed for use on nominal 120 volt, (within a range of 89 to 135 volts) 60Hz single phase A.C.

POWER DISTRIBUTION

The main frame and card cage with backplane shall distribute all necessary operating power from the power supply module to all other modules of the unit. "Crowbar" type SCR surge circuits shall be provided to protect all components from power surges.

Fuse protection shall be provided for the 115 AC input and the 24 VDC power output. The fuses will be located on the front of the controller.

PROTECTION

The main frame shall be provided with a fuse for the 120 volts, 60Hz A.C. supply to the unit and a fuse for the 24 volt D.C. external output from the unit.

SWITCHES AND CONNECTORS

The switches and connectors and any other components required for operation and adjustment of the unit shall be mounted on the front panels. All component parts and terminals shall be readily accessible when the modules are removed for maintenance, testing and servicing.

CUSTOM CIRCUITS

The use of custom LSI integrated circuits in the controller unit is expressly prohibited.

ENVIRONMENTAL REQUIREMENTS

The zone master controller shall meet the environmental conditions required of control equipment as specified in NEMA Standard TS1-1983.

QUALITY ASSURANCE REQUIREMENTS

The zone master controller shall meet the following factory acceptance test and design approval test requirements in accordance with Section 6.1 of the Special Requirement specification. The contractor shall prepare all required test procedures and data forms for approval by the Engineer.

FACTORY ACCEPTANCE TESTS

The bidder or manufacturer shall conduct or cause to be conducted, as a part of the factory acceptance test procedure, environmental testing of all units delivered under this contract. The environmental test procedures to be followed shall be those of the transient voltage, temperature, low voltage and high voltage portions of the environmental tests specified in the NEMA Standards Publication for Traffic Control Systems TS1-1983 or latest revision.

The bidder or manufacturer shall furnish all data taken during these tests to the Engineer.

DESIGN APPROVAL TESTS

The design approval tests specified in NEMA Standard TS1-1983 or latest revision shall be performed for each zone master controller supplied.

METHOD OF MEASUREMENT

Each zone master controller furnished, and accepted by the Engineer will be measured as a single unit.

BASIS OF PAYMENT

Payment for each zone master controller will be made for the measured quantity as the contract price for each. The unit price shall include all labor, tools, materials, equipment and incidentals necessary to meet the specifications, including a five year warranty.